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REDUCTION OF WOOD USAGE IN COAL MINING

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July 1984

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14 pp

ENERGY RESEARCH PROGRAM
COAL RESEARCH LABORATORIES
DIVISION REPORT ERP/CRL 84-25(IR)

MICROMEDIA

OCT 26 1984

85-0249/

REDUCTION OF WOOD USAGE IN COAL MINING

by

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SUMMARY

Wood has certain characteristics that make it a desirable material for use in underground mines.

These characteristics are:

1. Its ability to yield under compressive stress whilst providing increasing levels of resistance to such stress.
2. Its low density which makes it suitable for handling without undue exertion by mine personnel, and does not make for excessive weight in its transport into the mine in bulk.
3. It is also a suitable material on which a miner can exercise his skills with tools such as a saw or an axe to slot, notch and shape it to good fits.

Despite such favourable characteristics its extensive use in CBDC mines is now under question. The question centres on its flammability and the ease with which serious fires can propagate where continuous flame paths are available through its extensive use underground.

The uses of wood in mines are reviewed and priorized and alternatives to the uses of wood are proposed that might have benefits both in cost and in improved support.

It is not considered a practicable or desirable aim to eliminate the use of wood altogether from the mines.

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RÉDUCTION DE L'UTILISATION DU BOIS DANS LES MINES DE CHARBON

par

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SOMMAIRE

Le bois possède certaines caractéristiques qui en font un matériau qu'on désire utiliser dans les mines souterraines.

Ces caractéristiques sont les suivantes:

1. Capacité de fléchir sous les efforts de compression tout en fournissant des niveaux croissants de résistance à cette contrainte.
2. Sa faible densité qui facilite sa manutention et son transport en vrac par le personnel de la mine.
3. Le bois est aussi un matériau qui convient aux travaux du mineur qui peut faire des rainures, des entailles et le réduire aux dimensions requises.

Bien que ces caractéristiques soient positives, l'utilisation du bois dans les mines de charbon du Cap Breton est remise en question. On examine surtout les propriétés d'inflammabilité du bois et la rapidité avec laquelle des incendies sérieux peuvent se propager dans les couloirs hautement inflammables des mines lors de son utilisation sur une grande échelle sous terre.

Dans ce rapport, on réexamine l'utilisation du bois dans les mines et on souligne l'importance de trouver des solutions de rechange qui peuvent être avantageuses tant du point de vue économique que du point de vue de soutient amélioré.

On ne croit pas qu'il soit possible ou souhaitable à l'heure actuelle d'éliminer totalement l'utilisation du bois dans les mines.

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INTRODUCTION

This report is to be regarded as a preliminary discussion document. Its purpose is not to evaluate the economics consequent upon the reduction of the use of wood in the CBDC mines but to suggest by intuitive processes reasonably achievable alternatives and methods that will not materially add to the level of costs.

The presence of methane and coal dust as igniting or incendive agents are not considered to be part of any discussions covered by this report.

The history of fires excepting those due to spontaneous combustion have involved the ignition of an initial local heat source sufficient to raise surrounding materials to their temperatures of ignition.

The initial heat sources are such materials as rags, trashpaper, oils, greases, wood and etc. that in relation to coal require thermal inputs of a lower calorific order to initiate their combustion with flame.

The control of any hazard with respect to all such materials excepting wood is a matter of good housekeeping habits, and the proper storage, distribution and use of such hazardous substances in and about mines.

WOOD FIRE HAZARDS

In order to estimate the hazard that wood presents it is necessary to priorize those places in a mine where its use is more extensive and more permanent, or where it is used in conjuction with other hazardous material, or in circumstances that are suggested as more hazardous. Such a prioriza-tion gives the following:

1. <u>Booster Fan Installations, Haulage Engine Rooms, Compressor Rooms Main Line Belt Installations and etc.</u>

   The circumstances surrounding such installations present particular fire hazards because of the juxtaposition of electrical switchgear, heated plant and machinery, and the repeated needs of lubricating such plant and machinery.

2. Main Roads and Gate Roads

The hazard here is in the extensive use of wooden laggings in gate and main roads.

The use of the term extensive indicates that laggings are imposed abundantly around the crown and shoulders of steel arches and overlapping consecutive arches in such a manner as to present continuous flame paths.

3. Cavities

The order of risk for cavities requires priorization within the topic.

A sizeable cavity formed in a return gate airway that is infilled and supported by a chock or chocks and other timber remains a danger since any CH_4 present in the return airway will tend to migrate and layer in the cavity where timber is also additionally present.

A lesser risk occurs with large cavities formed on longwall face lines as forward progress of the face will unload any chock and timber used to support and control the cavity into the cave of the goaf behind the face and bury it.

The order of risk on intake roadways is dependent on the service provided in such roadways in which are included electrical mains supplies, conveyor belts, diesel or other locomotives, men and materials transport systems. The order of risk may vary but will in probability be high.

A greater risk is nevertheless ensured if a fire were to occur in the proximity to such a cavity.

4. Roadway Intersections and Junctions

The potential for a fire is considered to be high because intersections are convenient storage places for materials including those that are flammable. Within their limits rail tracks are usually laid involving curves. There is in general a high level of activity. Derailments sometimes occur with the spillage of flammable materials on already present flammable materials. Where belt transfer points occur there are frequently some amounts of coal spillage.

Many of these junctions or intersections have their supporting system underpinned with as many as seven open cribs or chocks constructed from 5 ft x 6 in. x 6 in. chock or crib blocks.
Should one such a crib or chock catch fire it would burn fiercely due to the open nature of its construction.

5. Endless Under Rope and Conventional Rope Haulages

Friction kindling of wood, grease, or other flammable debris is a risk inherent in the use of endless under rope and conventional rope haulage systems.
The rubbing of such steel wire ropes on ferrous metallic surfaces can cause sparking and the gradual destruction of the properties of individual wires in the rope strands.
The friction of such ropes on wooden materials can raise temperatures to sufficient levels to cause their combustion.

6. Development Face Lines

Although the development of a longwall face line involves a fairly considerable usage of timber in the form of props, slabbed bars, chocks, and sundry items their use in such circumstances is warranted since their benefit is great and the risk is small.

7. Operating Longwall Faces

The use of split bars, booms and chock pieces to control guttering and minor cavities on longwall faces is seen as an essential use of wood.

REDUCTION OF WOOD FIRE HAZARDS

1. BOOSTER FAN INSTALLATION, HAULAGE ENGINE ROOMS, AND ETC.

The construction of any house, room, or chamber to accommodate any booster fan, haulage engine, compressor, or other such plant or machinery should be made only in stable ground.

If this is considered as a necessary premise then the construction materials should be exclusively fireproof.

Any ventilation doors that are considered as necessary for such installations should be made of steel and surrounded by steel frames set in masonry.

2. MAIN ROADS AND GATEROADS

Any system substituting the use of wooden lagging in the main and gateroads must not overlook a fundamental principle of strata control, that of the early prevention of bed separation.

To establish loose covering around the arches without the earliest contact with and the support of the roof beds will only serve to be self defeating as it will promote the earlier closure of main and gateroads where it is practised.

Three methods are proposed that acknowledge the principle of immediate contact and support:

Method 1

The use of wooden laggings be still continued, however their use must be be limited, and be used in conjunction with weldmesh panels.

The number of lagging pieces should be limited according to the arch size in use and should not for practical purposes exceed eleven in number.

The line of the laggings should be staggered consecutively from arch to arch to avoid contact with previously set laggings and so avoid any continuous flame paths.

Such a system should extend for a length of 20 m (20 yds) in every gate or main road and then be replaced by a fire break 3 m (3 yds) in length. Such a fire break would be formed by covering completely around the four steel arches, that will constitute the fire break with corrugated steel sheets backed behind with hessian bags. These bags will be either filled with small dirt on site or be delivered into the mine already filled with sand.

Method 2

The use of strutlag or similar fine mesh steel panels that provide supplementary struts and lagging.

These panels should be sprayed at the earliest possible time after they are put in position behind the arches with a suitable anhydrite mix to the face of the panels.

A further alternative using similar principles might be found in the use of grout filled envelopes set around the outsideof each arch on its installation and subsequently filled with cement/gypsum/anhydrite grout or foamed cement.

Method 3

Would involve a change in the method of forming in seam main gateroads from arch profiles to rectangular and trapezoidal profiles.

The necessary height would be formed by dinting or brushing in the floor and support would be provided by a pin jointed combination of legs set to a roof girder.

The natural roof of the seam would receive supplementary support from weldmesh panels set over the girders. Either one or two friction type yielding props could be used as middle sets under the central span of the girder.

The formation of gateside packs where longwall advancing faces are in operation by both solid and open type cribs or chocks has a high potential for a fire hazard because of the continuous flame paths available from such a method of construction.

Correctly designed monolithic packs provide a suitable alternative to the use of such chocks.

For greater economics the same grout/cement product could be used to build the packs as is used behind the grout filled envelopes set around the outside of the arches.

There is available within the community of this province a number of sources of alternative materials that would form suitable cementitious materials. These materials combine the required characteristics of short curing times and suitable compressive strengths and can be placed by pneumatic means. An added benefit of adopting such a system is that it would prevent goaf leakage from the intake gate.

3. CAVITIES

The support of larger cavities formed in main and gateroads by a chock or chocks and timber must remain an acceptable method to control the roof and sides of such a cavity initially.

A decision should be made on the site of the cavity with respect to the hazard it presents. If due to it being sited where there are measurable quantities of methane in the body of the ventilating current then it might be prudent to shutter in the base of the cavity and infill it by the injection of one of the quick hardening cementitious foamed materials that are available.

4. ROADWAY INTERSECTIONS AND JUNCTIONS

The underpinning of the structures that support roadway junctions and intersections by large cribs or chocks appears to result from problems with the design of such structures. These problems are:

(i) The use of clevis attachments to join the legs of carrier beams to such beams.

(ii) Arbitrary selection of carrier beam sections without respect to their section moduli and the loads and stresses that will be be imposed upon them.

(iii) A similar arbitrary selection of runner beams.

(iv) Lack of bracing throughout the structure.

The support of roadway junctions and intersections requires structures with a degree of rigidity and no under design with respect to their probable loading.

An examination of the support requirements for intersections and junctions throughout CBDC operating mines suggests that 3 or 4 standard designs will fulfill the needs for the support of roadway intersections.

The fabrication of standard designs should be supportive of local local industries within Cape Breton Island.

5. ENDLESS UNDER ROPE AND CONVENTIONAL ROPE HAULAGES

The engineering requirements for the operation of endless under rope and conventional rope haulages need to be stated in terms of achieving a degree of standardization in their layout.

Standards should aim to ensure that suitable pulley and roller systems are installed and maintained that will preclude the possibilities of frictional sparking and rubbing where any such haulages are operating. This will require engineering of the systems for the layout of curves, crossings, changeovers, access through ventilation doors, and etc.

6 & 7 DEVELOPMENT FACE LINES AND LONGWALL FACES

With care and attention these are not seen as sites that are likely to produce any fires through the use of wood.

WOOD ALTERNATIVES

Some of the alternatives that are currently in use within the European and U.S. coal mining communities are listed following:

1. The fire retardant treatment of wood. This approach is notstrictly a wood alternative but involves chemical treatment within pressure kilns. The costs of such a process are estimated as increasing the costs of the wood used in coal mines by between 75% - 85%.
2. Fibreglass beams and posts. These have been successfully used in certain mines in the U.S. and evaluation trials are continuing on their further use.

3. Plain and Reinforced Concrete blocks. These are used in Europe for the formation of high strength circular roadways and for the lagging of roadways.

   Lagging has included both boards placed behind the arches and also slotted end boards to fit within the flanges of steel arches. This latter use is considered to give both and effective covering and an increase in the lateral stability of the arches.

4. Concrete Chock and Crib pieces. These have been produced in foamed concretes, plain concretes, layered mesh reinforced concretes, and steel fibre reinforced concretes.

   Their use has included, the formation of gateside packs in longwall advancing mining, their building in both solid and open forms for the support of entries that are used twice adjacently in longwall retreat mining, and for general cribbing and chocking purposes.

   In certain operations the replacement of wood by concrete chock pieces has produced cost benefits.

5. Pumped and pneumatically placed cements. Quick setting cements can be produced of both high and low densities from a variety of materials. Their uses have included shotcreting, the formation of gateside packs, spraying behind arches, infilling cavities, and the formation of a centre pillar for the support of wide entries that require conversion into dual entries.

The local availability of suitable cementitious materials such as sands, gravel, flyash, gypsum, etc. should be noted.

With such an availability local industries could be established to support the needs of coal mining.

PROPOSED PROGRAM

From some of the discussion that has preceded, it should be apparent that there are available a number of replacements for wood.

Such replacements acknowledge a range of duties that include those that are most likely to be encountered within the mining conditions here in the Sydney Coalfield.

In considering a programme for the replacement of wood it is suggested that the following sequential steps be taken:

1. A commital to a literature review of the state of art and technology of wood replacement materials.
2. A definition of the requirements of wood replacement materials for various applications underground.
3. A laboratory testing programme of such properties as density, strength, failure modes, and etc. to match the defined requirements of wood replacement materials for various applications underground based upon locally available materials.
4. Trial demonstrations in the underground mines.

CONCLUSIONS

This report is by no means an endeavour to cover all the materials, methods, and systems that are available for the substitution of wood in underground coal mines.

Certain fire hazards that occur through the use of wood in mines have been mentioned and alternatives that for the greater part do not involve any extensive alterations to methods and systems are discussed.

Certain fire hazards are also mentioned that are not so self evident but on the balance of judgement must also be regarded as real.

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